

# BIOVISION

## UNLOCKING LIFE SCIENCES

### GRADE 12





# BIOVISION UNLOCKING LIFE SCIENCES GRADE 12

” Where Wonder Meets Knowledge.”



## Contributors

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## Motivational Message

Dear Learner,

You can achieve greatness! Every page you turn and every concept you master brings you closer to success. Let this journey through Life Sciences ignite your curiosity and strengthen your determination. Remember, your future is in your hands — and it begins with belief in yourself. Stay focused, stay hungry, and never give up! I, **Anani Bova**, wish you nothing but success, strength, and a bright future. May this guide help you rise above challenges and reach your full potential.

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### What This Study Guide Will Do for You

This study guide is designed to make Grade 12 Life Sciences easier to understand and more engaging. It will:

- **Break down complex topics into simple explanations.**
- **Provide key definitions, diagrams, and examples for better learning.**
- **Help you prepare for exams with summaries, questions, and tips.**
- **Build your confidence and deepen your knowledge of the living world.**

Let BioVision: Unlocking Life Sciences be your learning companion — clear, reliable, and focused on your success.

# Life's Building Blocks: From Biochemistry to Multicellular Systems

## DNA: THE CODE OF LIFE



## Fundamental Terminology

|                                    |                                                                                                                                                                |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>DNA (DEOXYRIBONUCLEIC ACID)</b> | <b>A DOUBLE-STRANDED MOLECULE THAT CARRIES THE GENETIC INSTRUCTIONS USED IN THE GROWTH, DEVELOPMENT, FUNCTIONING, AND REPRODUCTION OF ALL LIVING ORGANISMS</b> |
| <b>RNA (RIBONUCLEIC ACID)</b>      | <b>A SINGLE-STRANDED NUCLEIC ACID THAT PLAYS A ROLE IN PROTEIN SYNTHESIS. TYPES INCLUDE MRNA, TRNA, AND RRNA.</b>                                              |
| <b>NUCLEOTIDE:</b>                 | <b>THE BUILDING BLOCKS(MONOMERS) OF DNA AND RNA</b>                                                                                                            |
| <b>GENE:</b>                       | <b>A SEGMENT OF DNA THAT CODES FOR A PARTICULAR CHARACTERISTIC(PROTEIN).</b>                                                                                   |
| <b>GENOME:</b>                     | <b>THE COMPLETE SET OF GENES OR GENETIC MATERIAL PRESENT IN A CELL OR ORGANISM</b>                                                                             |
| <b>PROTEIN SYNTHESIS:</b>          | <b>THE PROCESS BY WHICH CELLS MAKE PROTEINS CONSISTS OF TRANSCRIPTION (IN THE NUCLEUS) AND TRANSLATION (IN THE CYTOPLASM/RIBOSOME).</b>                        |
| <b>TRANSCRIPTION:</b>              | <b>1ST STAGE OF PROTEIN SYNTHESIS – MRNA IS FORMED FROM DNA CARRYING THE CODE FOR THE PROTEIN TO BE MADE.</b>                                                  |
| <b>TRANSLATION:</b>                | <b>2ND STAGE OF PROTEIN SYNTHESIS – AMINO ACIDS COMBINE TO FORM A PROTEIN</b>                                                                                  |
| <b>CODON:</b>                      | <b>THREE NITROGENOUS BASES, ONE AFTER THE OTHER, ON MRNA – THESE ARE COMPLEMENTARY TO THE TRIPLET ON DNA</b>                                                   |
| <b>ANTICODON:</b>                  | <b>THREE NITROGENOUS BASES, ONE AFTER THE OTHER, ON TRNA – THESE ARE COMPLEMENTARY TO THE CODON ON MRNA</b>                                                    |
| <b>MUTATION:</b>                   | <b>SUDDEN CHANGE IN THE SEQUENCE OF NITROGENOUS BASES</b>                                                                                                      |
| <b>DNA REPLICATION:</b>            | <b>THE PROCESS BY WHICH DNA MAKES AN EXACT COPY OF ITSELF BEFORE CELL DIVISION.</b>                                                                            |



|                              |                                                                                      |
|------------------------------|--------------------------------------------------------------------------------------|
| <b>mRNA (MESSENGER RNA):</b> | <b>mRNA CARRIES THE CODE FOR PROTEIN SYNTHESIS FROM DNA TO THE RIBOSOME</b>          |
| <b>tRNA (TRANSFER RNA):</b>  | <b>tRNA BRINGS AMINO ACIDS TO THE RIBOSOME TO FORM THE PROTEIN</b>                   |
| <b>rRNA (RIBOSOMAL RNA):</b> | <b>rRNA FORMS RIBOSOMES, WHICH ARE THE SITE OF PROTEIN SYNTHESIS</b>                 |
| <b>HYDROGEN BOND</b>         | <b>THE CHEMICAL BONDS THAT LINK BASE PAIRS IN THE DNA MOLECULE.</b>                  |
| <b>AMINO ACID</b>            | <b>MONOMERS (BUILDING BLOCKS) OF PROTEINS</b>                                        |
| <b>PEPTIDE BOND</b>          | <b>JOIN TWO ADJACENT AMINO ACIDS</b>                                                 |
| <b>CODON</b>                 | <b>A SEQUENCE OF THREE mRNA BASES THAT CODES FOR A SPECIFIC AMINO ACID.</b>          |
|                              |                                                                                      |
|                              |                                                                                      |
| <b>ANTICODON</b>             | <b>A SEQUENCE OF THREE BASES ON tRNA THAT IS COMPLEMENTARY TO A CODON ON mRNA.</b>   |
| <b>HEREDITARY</b>            | <b>GENETIC INFORMATION PASSED ON FROM PARENT TO OFFSPRING</b>                        |
| <b>NUCLEOTIDES</b>           | <b>THE MONOMER (BUILDING BLOCK) THAT FORMS DNA AND RNA</b>                           |
| <b>DOUBLE HELIX</b>          | <b>THE SHAPE OF DNA CONSISTS OF TWO STRANDS JOINED TOGETHER AND TWISTED SPIRALLY</b> |

There are two types of nucleic acids in the human body –

- **DNA (deoxyribonucleic acid)**
- **RNA (ribonucleic acid).**

Together, these form the basis of all life on Earth. They consist of monomers (building blocks) called **nucleotides**

## STRUCTURE OF A CELL

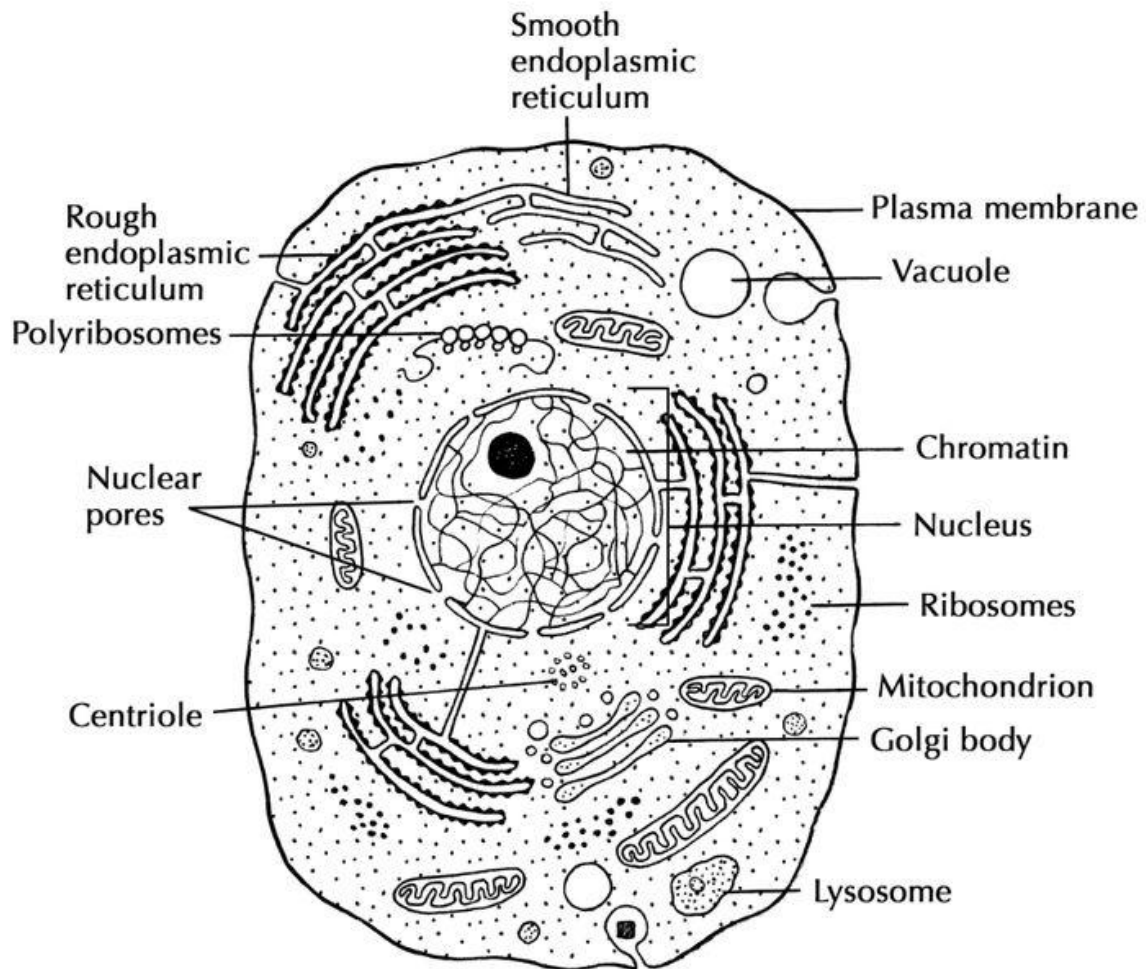


Figure 1: Structure of a cell

1. **Cell membrane** – outer layer that controls what enters and leaves the cell.
2. **Cytoplasm** – jelly-like fluid where cell activities happen.
3. **Nucleus** – control centre; contains DNA.
4. **Nucleolus** – makes ribosomes; found inside the nucleus.
5. **Mitochondria** – "powerhouse" of the cell; makes energy.
6. **Ribosomes** – make proteins.
7. **Endoplasmic reticulum (ER)** – moves materials around the cell.
  - **Rough ER** – has ribosomes; makes proteins.
  - **Smooth ER** – no ribosomes; makes fats (lipids).
8. **Golgi apparatus (Golgi body)** – packages and sends proteins.
9. **Lysosomes** – break down waste and old cell parts.
10. **Vacuole** – stores water, food, and waste.
11. **Cell wall** (plants only) – gives shape and support.
12. **Chloroplasts** (plants only) – where photosynthesis happens.
13. **Nuclear envelope** – A double membrane that surrounds the nucleus and controls what goes in and out through nuclear pores.

## DNA-DEOXYRIBOSE NUCLEIC ACIDS

Rosalind Franklin and Maurice Wilkins used X-rays to study DNA structure.

James Watson and Francis Crick discovered the structure of DNA.

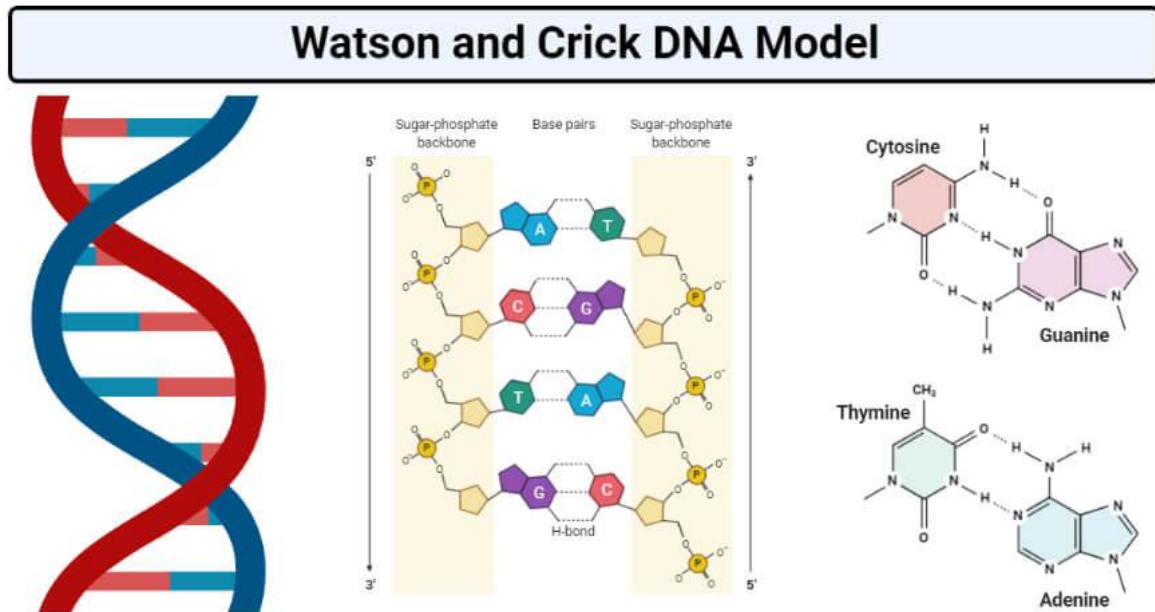


Figure 2: Watson and Crick model

## Three types of DNA and their location

- **MITOCHONDRIAL DNA**- The type of DNA found only in the mitochondria.
- **NUCLEAR DNA** -Type of DNA found in the nucleus – makes up genes on chromosomes.
- **CHLOROPLAST DNA**- Type of DNA found in chloroplasts (plants).

## STRUCTURE OF DNA

DNA, or deoxyribonucleic acid, is the hereditary material found in all living organisms. It contains the instructions necessary for building and maintaining an organism's body. Structurally, DNA is composed of two strands forming a **double helix**.

NB!!! THE NATURAL SHAPE OF DNA IS A **DOUBLE HELIX**



## NUCLEOTIDES

The building blocks or monomers of DNA are called Nucleotides

Monomers of DNA consist of two types:

- Purines: Adenine and Guanine
- Pyrimidines: Cytosine and Thymine

EACH NUCLEIC ACID IS COMPOSED OF A PHOSPHATE (P), A SUGAR MOLECULE (S), AND A NITROGENOUS BASE (NB).

### Nucleotide Structure

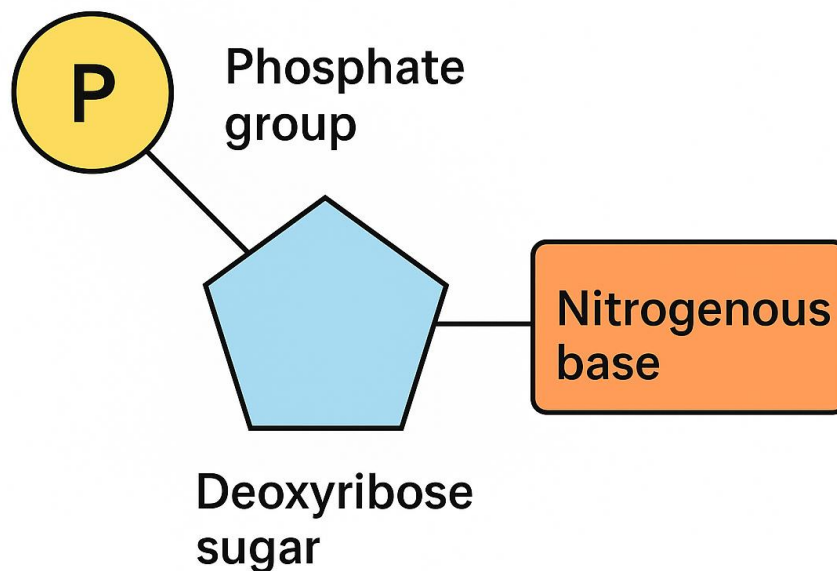


Figure 3: NUCLEOTIDE STRUCTURE

Nitrogenous base consists of 4 bases, which are joined together by weak **hydrogen bonds**:

- adenine
- Thymine
- Guanine
- Cytosine

## NB!!!! Base Pairing Rules

In DNA:

- **Adenine (A)** pairs with **Thymine (T)**
- **Guanine (G)** pairs with **Cytosine (C)**

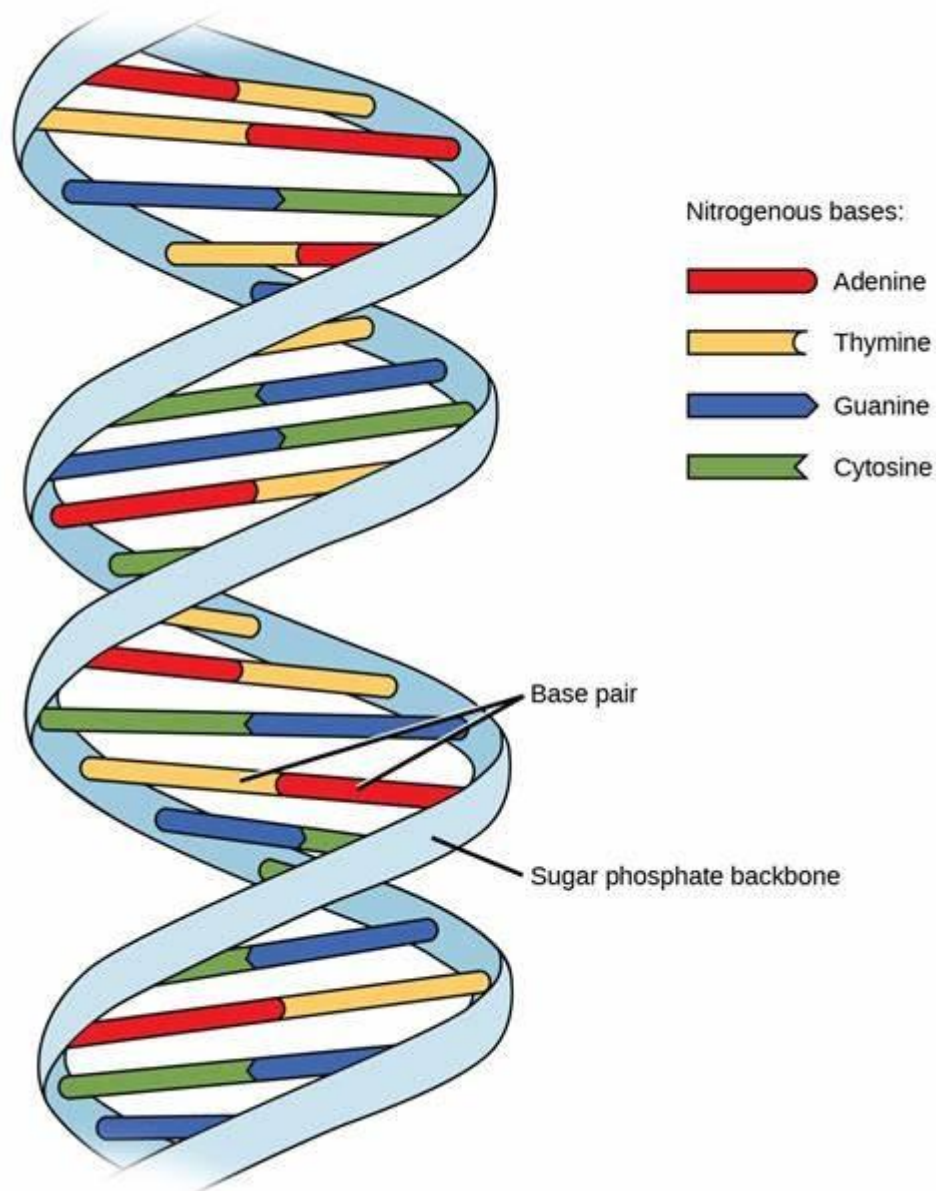


Figure 4: Structure of DNA

## The main functions of DNA include:

- Controls the functioning of cells
- Regulate the functioning of genes
- Passes on hereditary characteristics

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## DNA replication

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The process in which the DNA molecule makes its identical copy

- The double helix unwinds
- Weak hydrogen bonds between nitrogenous bases break
- To form two separate strands
- Each strand serves as a template
- To form a complementary DNA strand, using free DNA nucleotides from the nucleoplasm.
- Two identical DNA molecules are formed

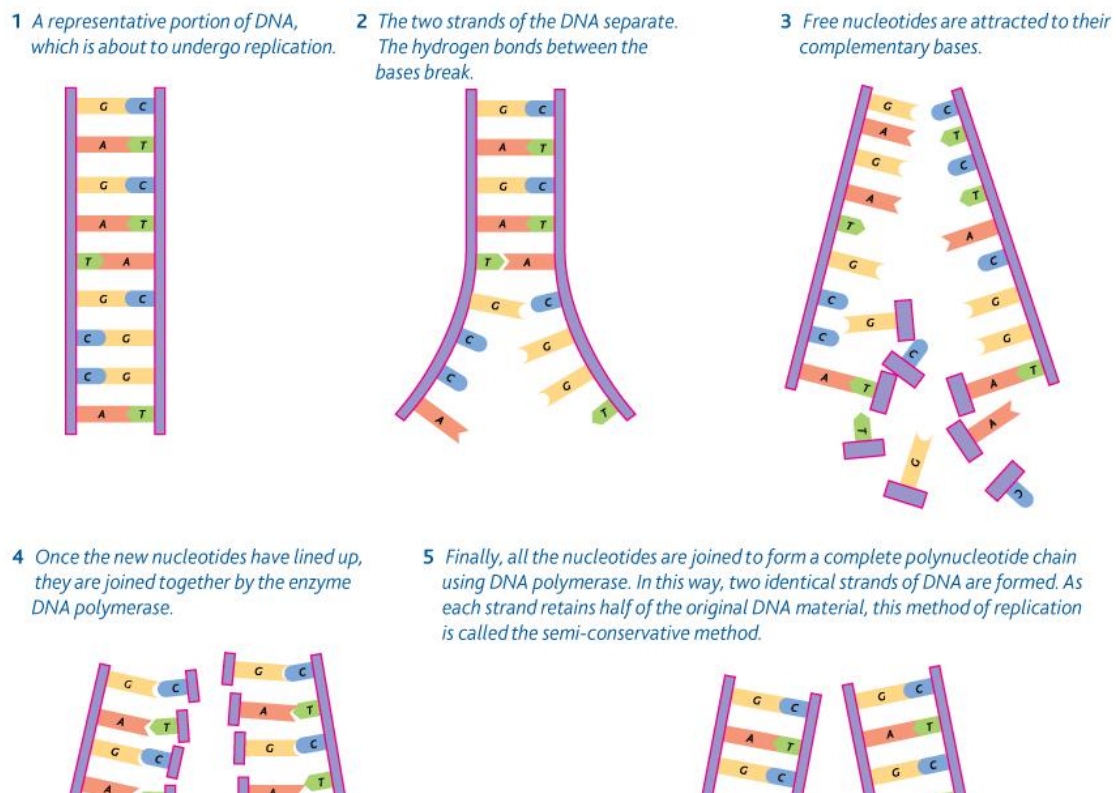


figure 5: DNA replication structure

[DNA REPLICATION PRESS TO WATCH](#)



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## DNA PROFILING

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A DNA profile is a unique pattern of an individual's DNA, created by analysing specific regions of their genetic code.

### USES OF DNA PROFILING / ANALYSIS

- To investigate crimes / resolve disputes-
- To identify organisms from their remains
- To identify family relationships other than paternity eg, Siblings or cousins
- To test for the presence of specific alleles/genes that cause a genetic disorder.
- To establish matching tissues for organ transplants

### Reason why DNA profiling cannot be reliable:

- Human error can affect result accuracy.
- Different lab methods may cause inconsistent results.
- Small DNA samples might not be unique.
- High costs limit access, especially in legal cases.
- Privacy risks – sensitive information could lead to discrimination.

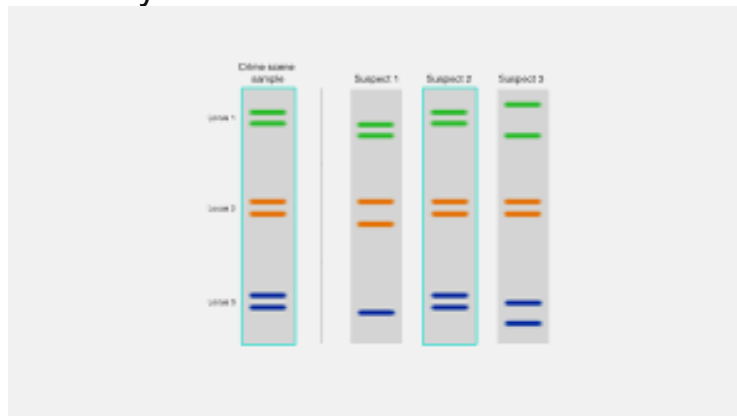


Figure 6: DNA profiling

# STRUCTURE OF RNA

RNA is a **single-stranded** nucleic acid that helps carry out the instructions in DNA to make proteins. RNA differs from DNA in that it does not contain thymine (T) as one of its nitrogenous bases. Instead, RNA contains **uracil (U)**, which pairs with adenine (A) during transcription. This substitution is one of the key structural differences between RNA and DNA, contributing to their distinct roles in the cell.

## Structure of RNA

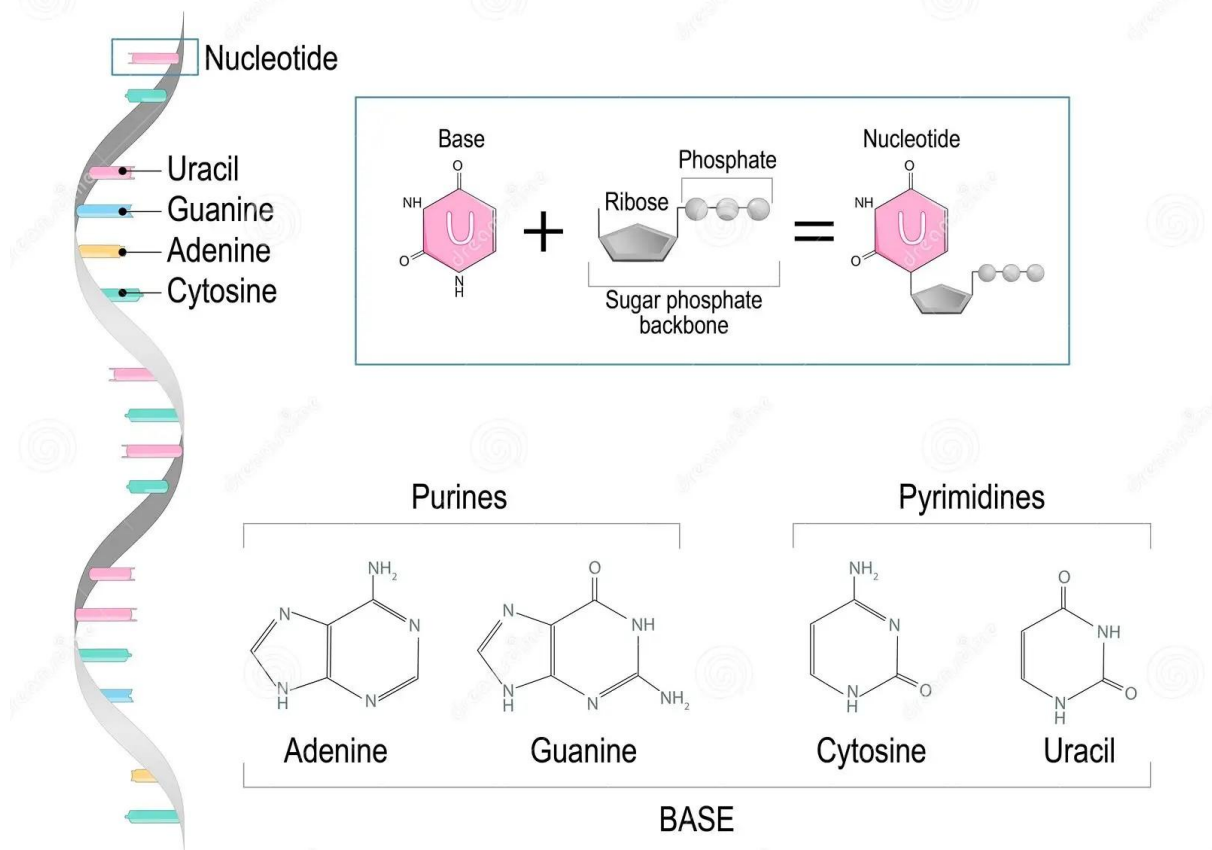


Figure 7: structure of RNA

## TYPES OF RNA

- **mRNA (Messenger RNA)**
  - Carries genetic code from DNA to the ribosome.
- **tRNA (Transfer RNA)**
  - Transfers amino acids to the ribosome during protein synthesis.
- **rRNA (Ribosomal RNA)**
  - Forms part of the structure of ribosomes.

### Similarities Between DNA and RNA:

- Both are made of **nucleotides**, which include a **sugar-phosphate backbone**.
- Both contain the **nitrogenous bases: adenine (A), guanine (G), and cytosine (C)**.
- Both are involved in **protein synthesis**.
- Both are **found in cells** and are essential for carrying genetic information.

### Differences Between DNA and RNA:

| Feature                 | DNA                               | RNA                                                   |
|-------------------------|-----------------------------------|-------------------------------------------------------|
| <b>Sugar</b>            | Deoxyribose                       | Ribose                                                |
| <b>Structure</b>        | Double-stranded helix (coiled)    | Single-stranded                                       |
| <b>Nitrogenous Base</b> | Thymine (T) present               | Uracil (U) replaces thymine                           |
| <b>Location in Cell</b> | Found only in the <b>nucleus</b>  | Found in the <b>nucleus, cytoplasm, and ribosomes</b> |
| <b>Function</b>         | Stores <b>genetic information</b> | Helps in <b>protein synthesis</b>                     |





# PROTEIN SYNTHESIS

- This is the process in which proteins are formed. The building blocks of proteins are **amino acids**.
- There are 20 different amino acids in the cytoplasm, which combine in various ways to form different proteins.
- The type and order of amino acids determine the structure and function of the protein.
- **Peptide bonds** link the amino acids together.
- The instructions for protein formation are coded in the DNA.
- A base triplet (3 nitrogenous bases on DNA) determines:
  - Which amino acid is added
  - The order in which amino acids are joined
- Proteins can have 50 to 300+ amino acids in their chains
- Protein synthesis occurs in two stages:

1. Stage 1: **Transcription**
2. Stage 2: **Translation**

# Transcription.

IT OCCURS IN THE NUCLEUS

stage 1

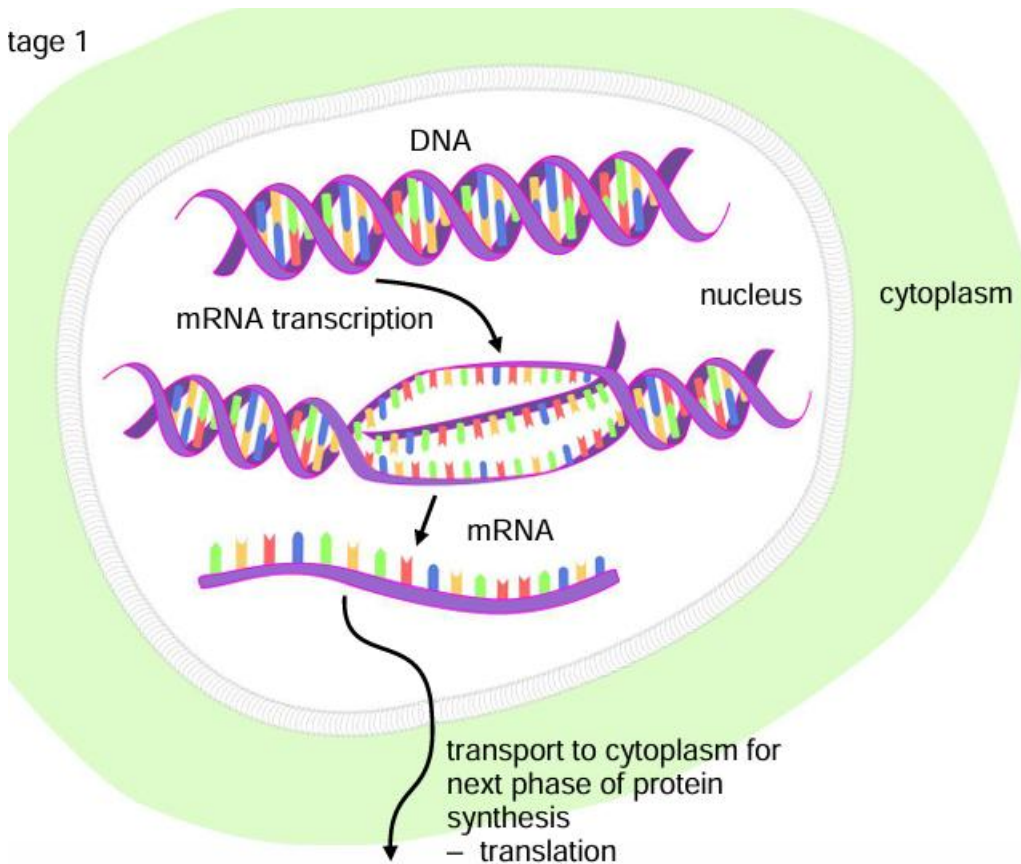


Figure 8 transcription

- The double helix DNA unwinds.
- The double-stranded DNA unzips/weak hydrogen bonds break to form two separate strands.
- One strand is used as a template to form mRNA
- using free RNA nucleotides from the nucleoplasm.
- The mRNA is complementary to the DNA.
- mRNA now has the coded message for protein synthesis.

# TRANSLATION

Occur in the cytoplasm

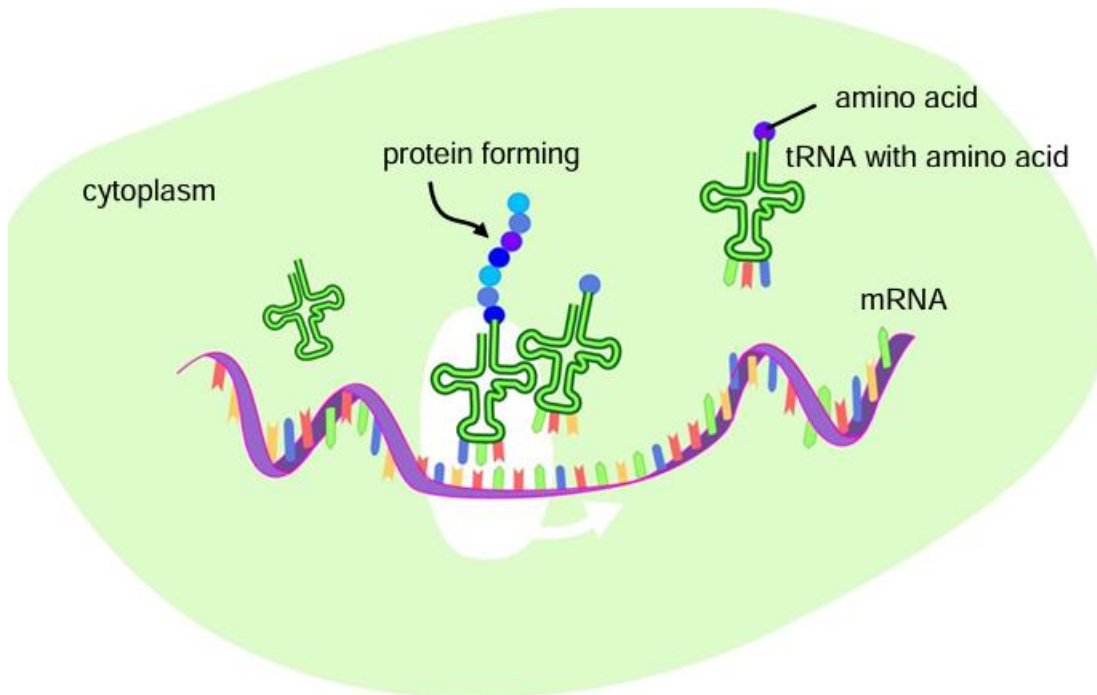


Figure 9: translation stage

- Each tRNA carries a specific amino acid.
- When the anticodon on the tRNA
- matches the codon on the mRNA
- Then the tRNA brings the required amino acid to the ribosome.
- Amino acids become attached by peptide bonds
- to form the required protein.

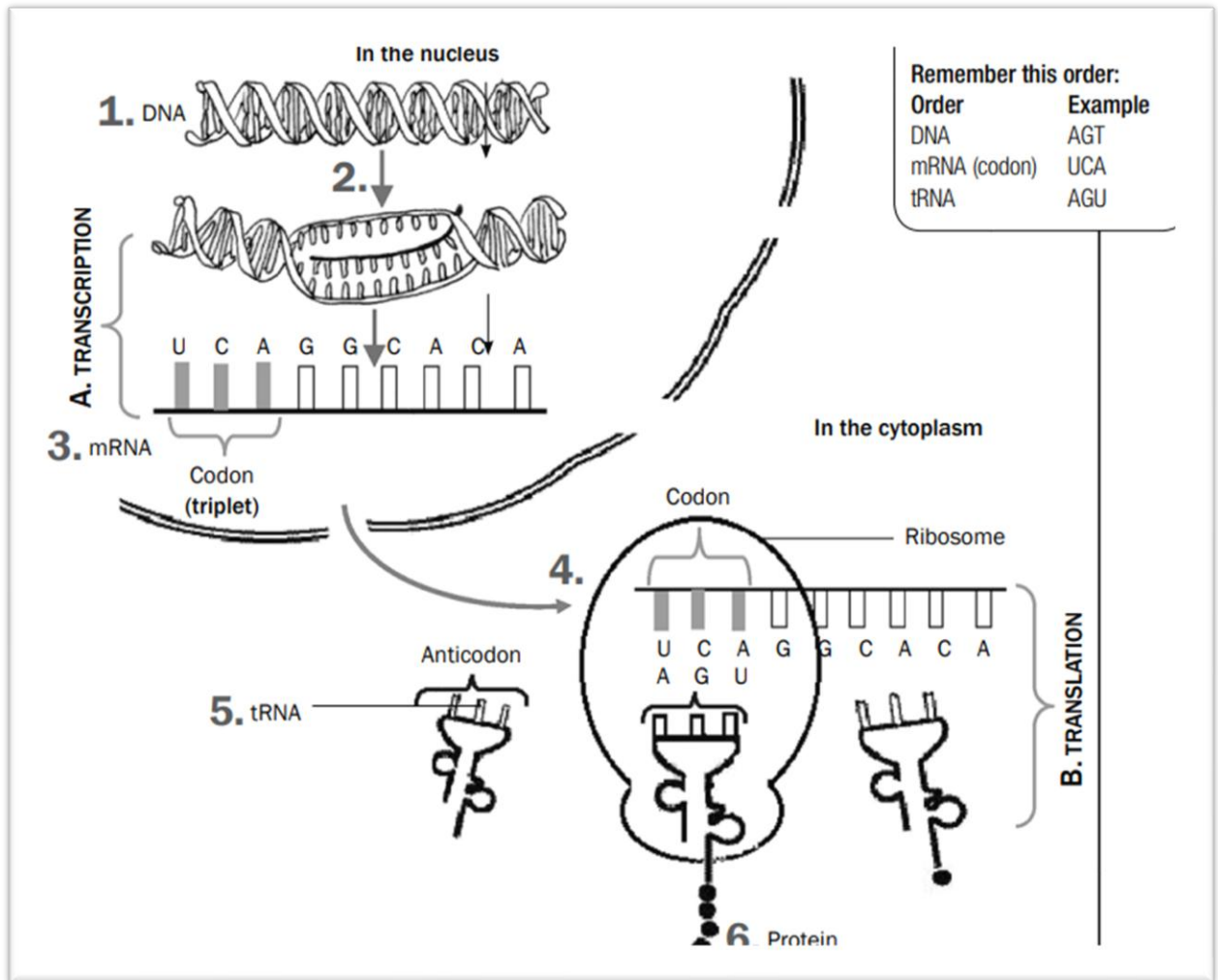


figure 10: protein synthesis stage

[press to watch: Protein synthesis process](#)